NETL
Office of Coal & Environmental Systems
Hydrogen Projects

Hydrogen Production Using Inorganic Membranes

Product Line: Gasification Technologies, Research and Development and Gasification Technology

Background/Description

Most refineries use high-pressure hydrogenation processes to reduce sulfur and aromatic content of products and process feedstocks. About 20% of the hydrogen generated must be purged from these processes to keep hydrocarbons from building up to excessive levels. These purge gases, which may contain up to 75% (volume) hydrogen, are usually used as refinery fuel. Recovery, rather than burning, of this hydrogen would have significant environmental and economic benefits to refiners.

One established way to recover the hydrogen is with organic membranes. However, inorganic membranes offer several advantages over organic membranes; they are more rugged, have higher temperature and pressure operating ranges, are more corrosion resistant in the environments of interest, and have higher hydrogen permeance. These membranes could be used at process conditions; hydrogen would not have to be cooled, separated, and reheated before reuse. The value of this process is in the increased yield of light, high value products with a considerable reduction in overall energy usage. The technology could also help separate hydrogen from synthesis gas and other mixtures

Goal

The goal of this project was to develop high temperature (600ºC) inorganic membranes that will efficiently separate hydrogen from synthesis gas, refinery purge gases, and hydrogen/carbon dioxide mixtures.

Benefits

The work should result in decreased emission of green house gases because of reduced energy usage. The technology has potential for being used in any process where hydrogen separation is required.

Summary of Findings

Separation efficiency for hydrogen/light hydrocarbon mixtures was examined for three inorganic membranes. Five binary gas mixtures were used in this study: H_2/CH_4, H_2/C_2H_6, H_2/C_3H_8, He/CO_2, and He/Ar. The membranes examined were produced during a development program at the Inorganic Membrane Technology Laboratory in Oak Ridge and provided to us for this testing. One membrame was a (relatively) large-pore-diameter Knudsen membrane, and the other two had much smaller pore sizes. Observed separation efficiences were generally lower than Knudsen separation but, for the small-pore membranes, were strongly dependent on temperature, pressure, and gas mixture, with the most condensable gases showing the strongest effect. This finding suggests that the separation is strongly influenced by surface effects (i.e. adsorption and diffusion), which enhance the transport of the heavier and more adsorption-prone component and may also

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